U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Energy Efficient Mobility Systems Program

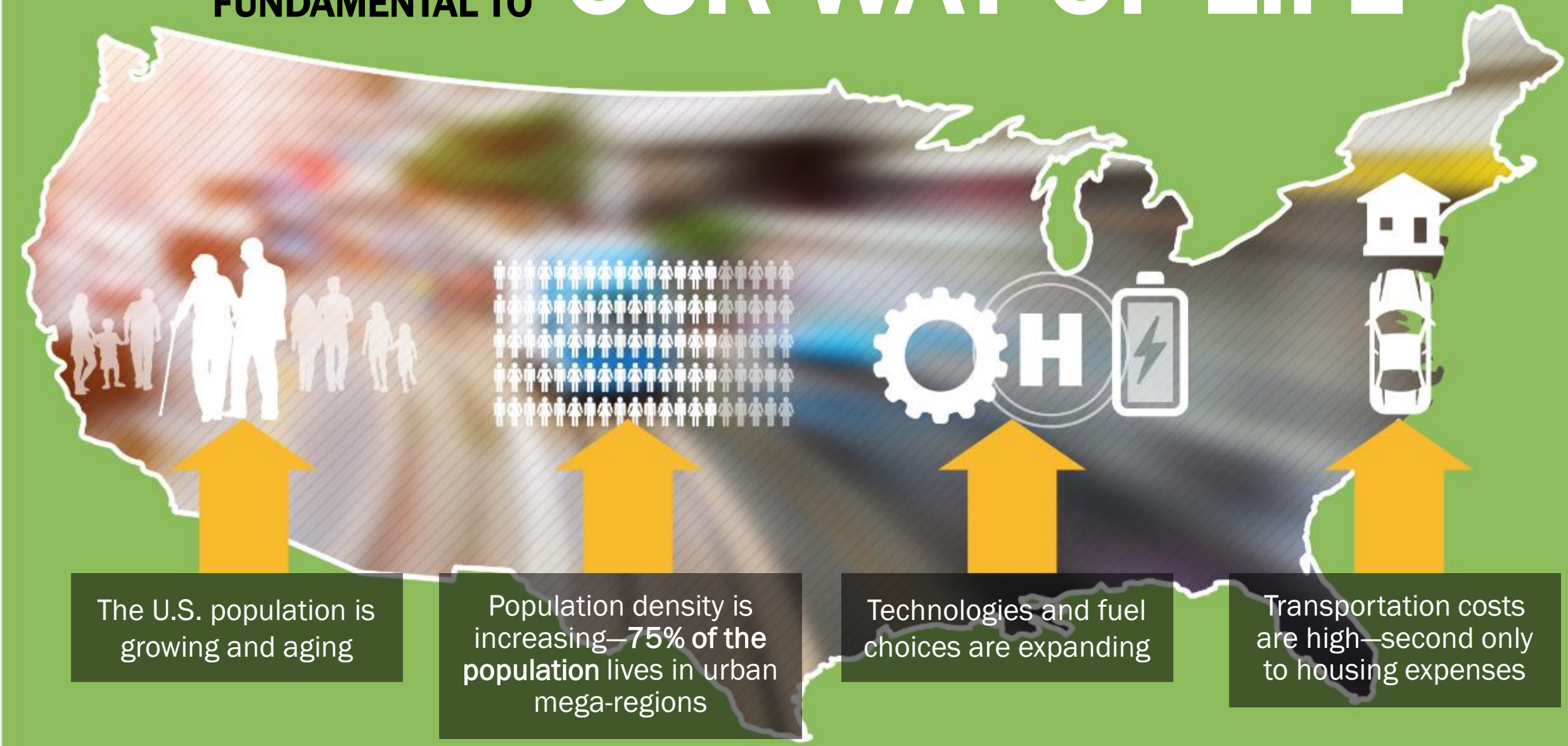
David L. Anderson, Program Manager

Vehicle Technologies Office Annual Merit Review, June 18, 2018






TRANSPORTATION IS FUNDAMENTAL TO OUR WAY OF LIFE



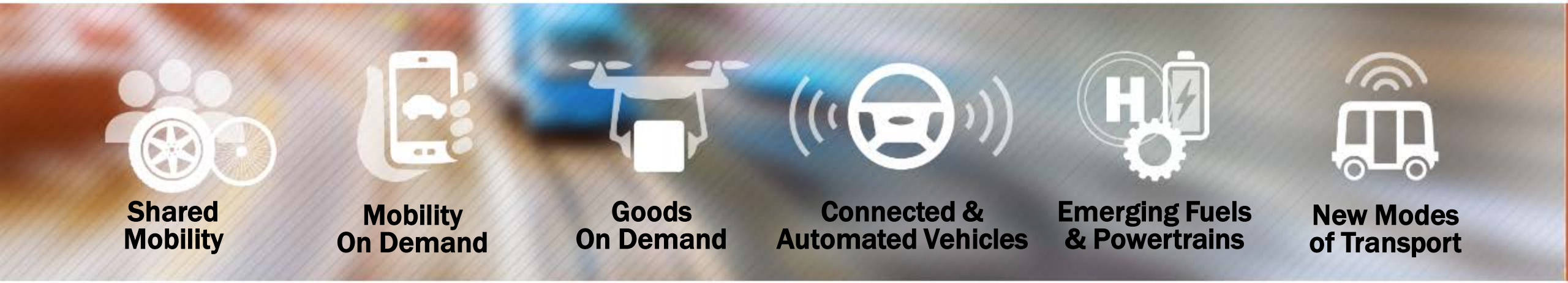
The U.S. population is growing and aging

Population density is increasing—**75% of the population** lives in urban mega-regions

Technologies and fuel choices are expanding

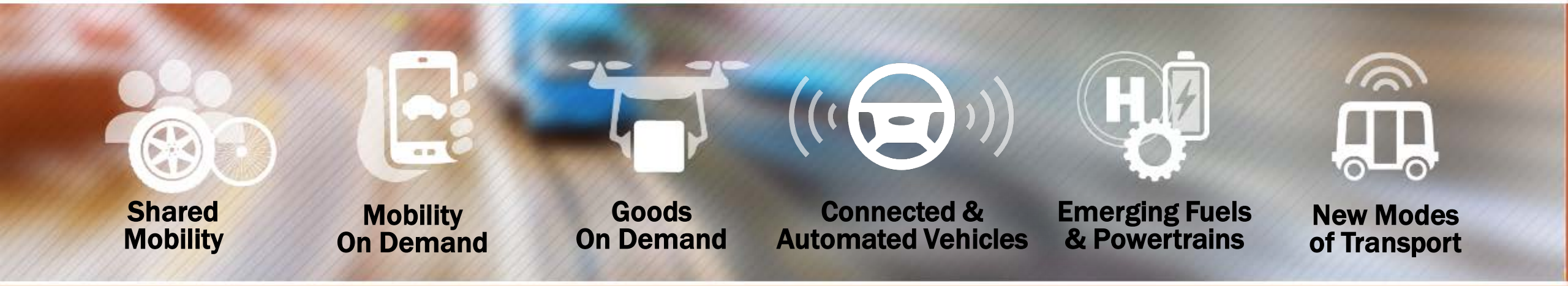
Transportation costs are high—second only to housing expenses

NEW TECHNOLOGIES & BUSINESS MODELS ARE DRIVING DISRUPTION



PIONEERING RESEARCH

EXPLORES POTENTIAL ENERGY IMPACTS



NEW CHALLENGES BRING

NEW OPPORTUNITIES

IN THE ENERGY EFFICIENT MOBILITY SYSTEMS PROGRAM

NEW OPPORTUNITIES

REQUIRING VTO TO EXPAND ITS FOCUS

Component — Vehicle — Transportation System

EEMS VISION, MISSION, GOALS

ENERGY EFFICIENT MOBILITY SYSTEMS

VISION

An affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption.

ENERGY EFFICIENT MOBILITY SYSTEMS

MISSION

The EEMS Program conducts early-stage R&D at the vehicle, traveler, and system levels, creating new knowledge, tools, insights, and technology solutions that increase mobility energy productivity for individuals and businesses.

STRATEGIC GOAL #1

Develop new tools, techniques, & core capabilities to understand & identify the most important levers to improve the energy productivity of future integrated mobility systems.

STRATEGIC GOAL #2

Identify & support early stage R&D to develop innovative technologies that enable energy efficient future mobility systems.

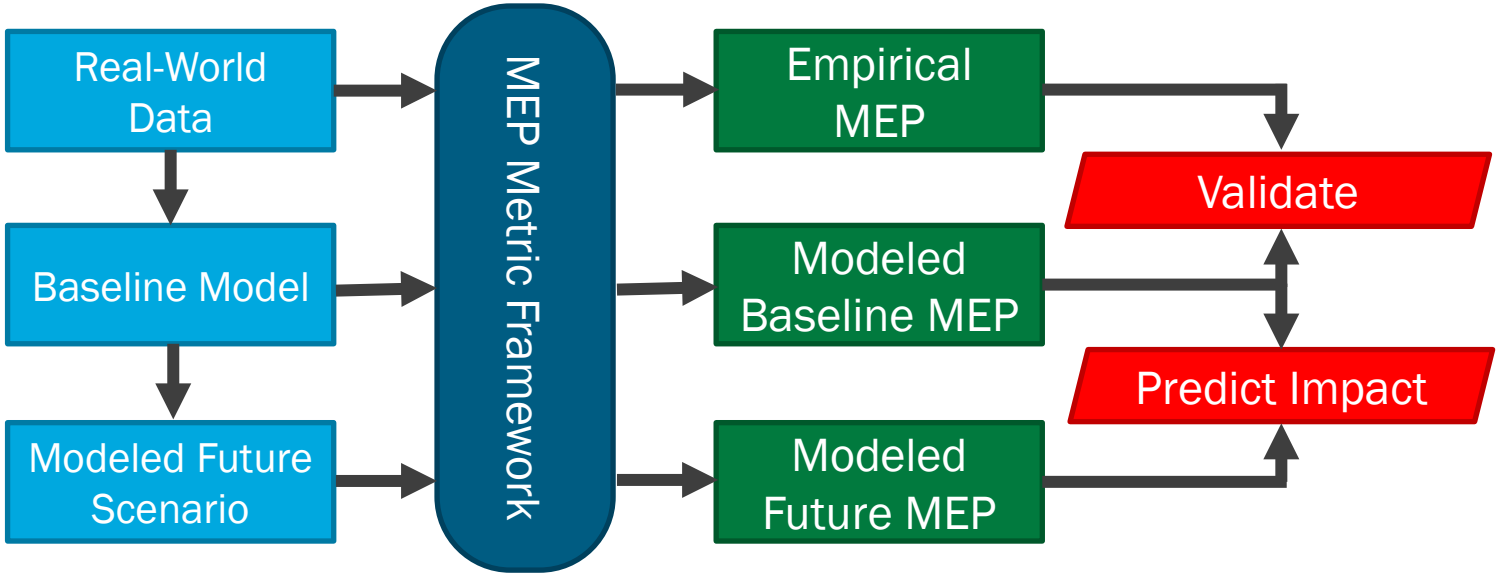
STRATEGIC GOAL #3

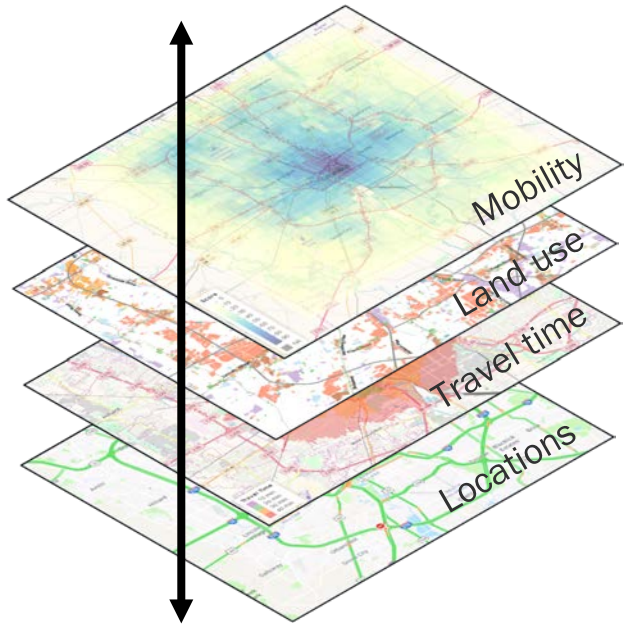
Share research insights, and coordinate and collaborate with stakeholders to support energy efficient local and regional transportation systems.

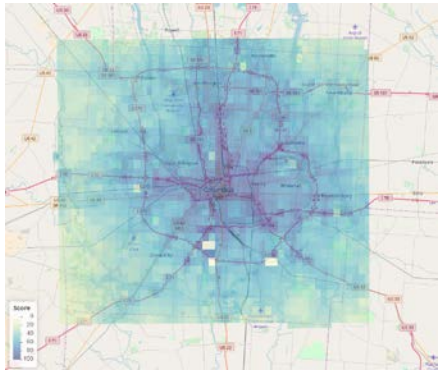
A NEW METRIC: Mobility Energy Productivity

Scientific Approach & Accomplishment

- A first-of-its-kind, high-resolution, **comprehensive accessibility metric that considers energy dependency**.
- The **Mobility Energy Productivity (MEP)** Metric measures the fundamental quality of transportation networks to connect people with goods, services, and employment that define a high-quality of life.
- **Beta testing** carried out for **Columbus, OH**. Efforts underway to extend to other cities.
- FY 18 research focuses on developing an easily adaptable methodology that various **SMART Mobility** research tasks can utilize to quantify the impact of technologies or strategies on the MEP of a region.







Driving

All Modes Except Driving

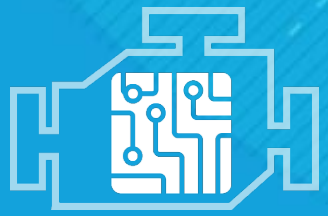
MEP Metric for Columbus, OH – Preliminary Analysis

ACHIEVING GOALS

SMART Mobility Lab Consortium

Living Labs

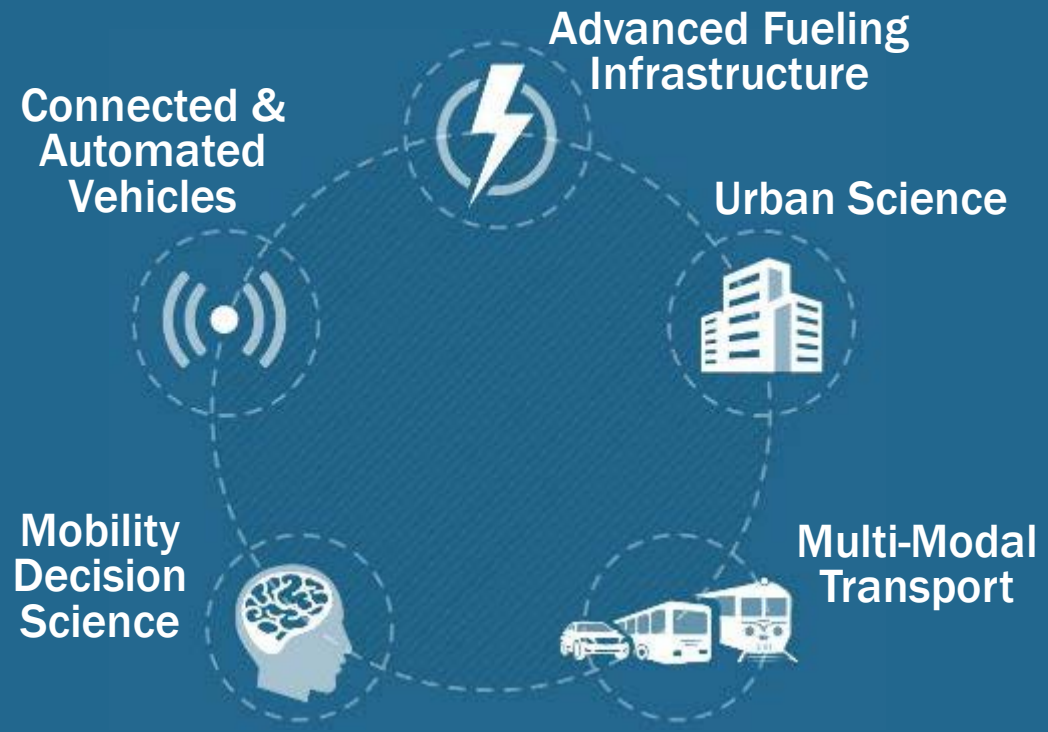
THROUGH FIVE EEMS ACTIVITY AREAS



Advanced R&D Projects

Core Evaluation & Simulation Tools

HPC4Mobility & Big Transportation Data Analytics



U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

7-Lab Consortium
30+ Projects
65 Researchers
$15M in FY2018

Developing tools, knowledge, insights, and understanding about the future of mobility

Argonne NATIONAL LABORATORY · Idaho National Laboratory · Pacific Northwest NATIONAL LABORATORY · BERKELEY LAB Lawrence Berkeley National Laboratory · OAK RIDGE National Laboratory · Los Alamos NATIONAL LABORATORY EST. 1943 · NREL NATIONAL RENEWABLE ENERGY LABORATORY

ADVANCED

RESEARCH & DEVELOPMENT

4 University Projects, $6.4M (Through FY2017)

Vehicle & Traffic Control Algorithms

Data Collection from CAV Deployments

CAV Vehicle & Transportation Simulation

Transportation System Optimization

CAV Vehicle-in-the-Loop Testing

NEW OPPORTUNITIES FOR

HPC4MOBILITY & BIG DATA ANALYTICS

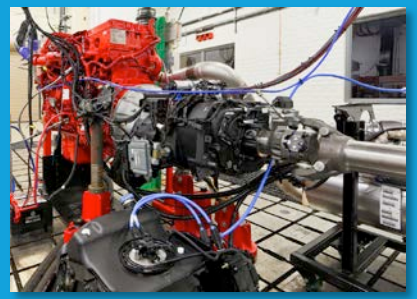
$5.5M planned in FY2018

- Reinforcement Learning-based Algorithms for Vehicle Detection/Classification & Traffic Control
- Deep-Learning and Simulation for Resilient Autonomous Vehicle Development
- Digital Twin of Regional Transportation Systems for Real-Time Cyber-Physical Control (LA Metro, Chattanooga)

CORE
EVALUATION & SIMULATION
TOOLS & CAPABILITIES

AMTL: light-duty vehicle testing to provide critical data for model validation

TSDC: secure data center for real-world GPS-based transportation data analytics



VSI Lab: integrates advanced combustion, electric-drive, controls, and fuels within emissions constraints

POLARIS

POLARIS: agent-based regional transportation network simulation

FASTSim: user-friendly energy, performance, and cost estimation of future automotive technologies

Autonomie: high-fidelity simulation of vehicle components and controls

AUTONOMIE

FleetDNA: commercial fleet vehicle operational data clearing-house & visualization tool

ReFUEL: evaluation of advanced medium & heavy-duty vehicle technologies

USING REAL-WORLD DATA TO UNDERSTAND ENERGY IMPACTS

LIVING LABS

3 Projects, $4.9M in FY2017

ELECTRIC SHARED MOBILITY
Seattle, Portland, NYC, Denver
Uber, GM's Maven, BMW's ReachNow

ELECTRIC LAST MILE
Austin
Pecan Street, CapMetro

ENERGY EFFICIENT FREIGHT LOGISTICS
NYC-Albany Corridor
Rensselaer Polytechnic Institute, freight carriers & receivers, urban supply chain

Up to $20M Planned in FY2018

- High Performance Computing for Transportation Hubs
- First/Last Mile for People/Goods Movement
- System-Level Data for Energy Efficient Mobility
- Fuel Efficient Platooning
- Multi-Unit Dwelling & Curbside Residential Charging Innovation
- Open Topic

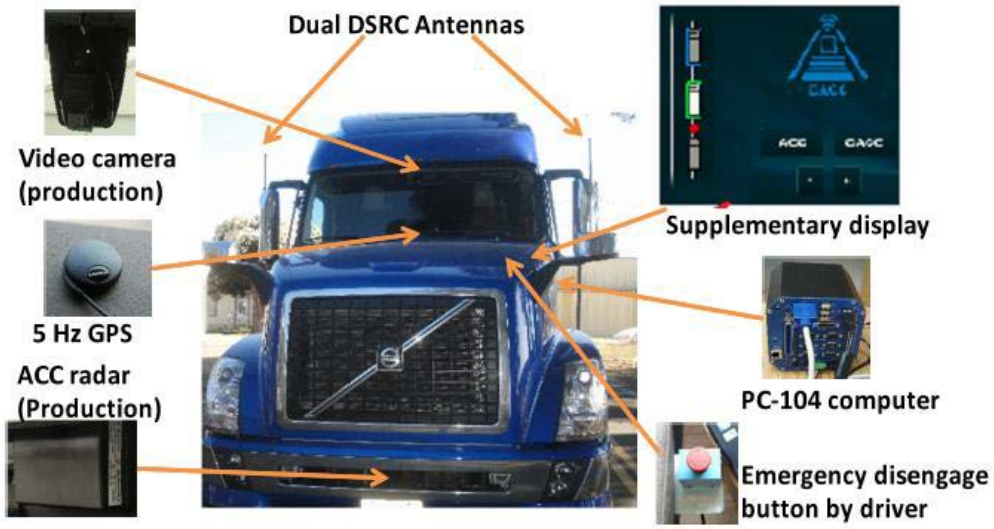
EEMS BUDGET

Funding ($k)	FY 2017 Enacted	FY 2018 Enacted
Energy Efficient Mobility Systems (including Vehicle Systems)	$24,385	$41,000

- Energy Efficient Mobility Systems was funded through Analysis and Vehicle Systems Program funds in FY 16/17.

- The FY2018 Enacted Budget represents a dedicated EEMS Budget Line Item.

ACCOMPLISHMENT: Truck Platooning Testing

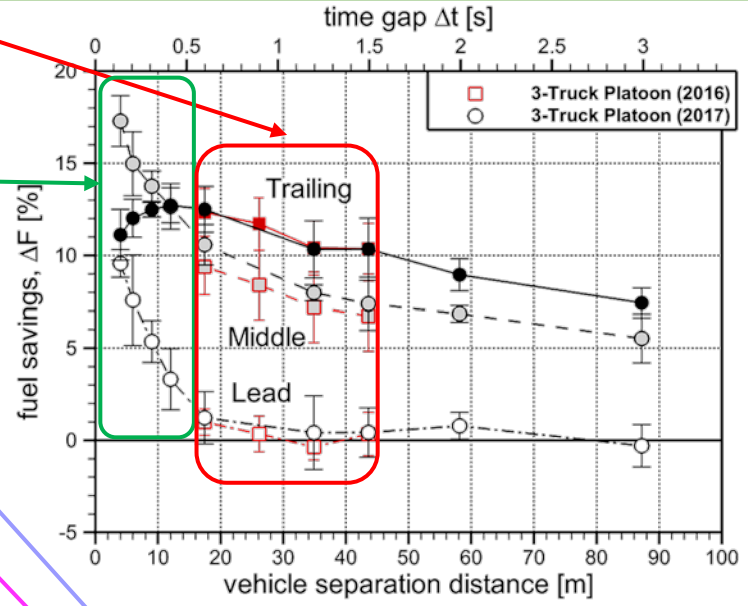


Transport Canada's Motor Vehicle Test Centre, Blainville, Quebec

Multiple Test Scenarios: Variation in speed, separation distance, traffic cut-in, etc.

Previous limit of understanding

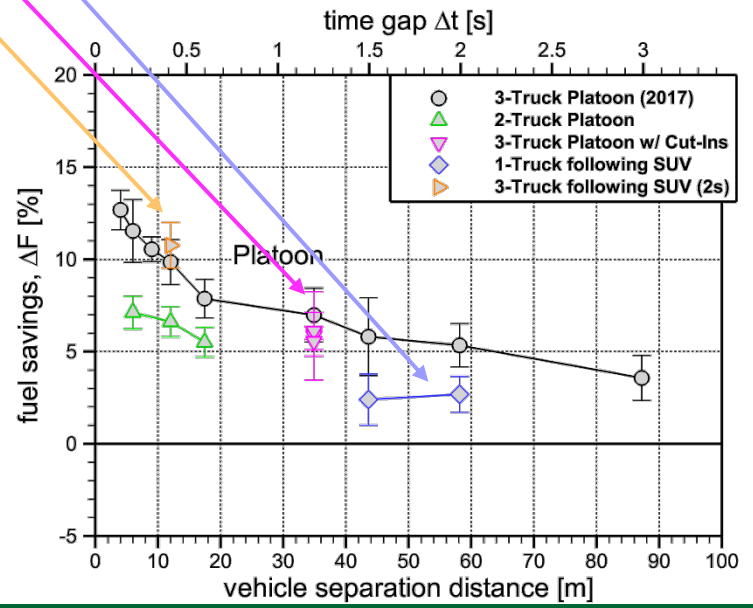
New knowledge of effects at close separation



Effect of SUV leading single truck

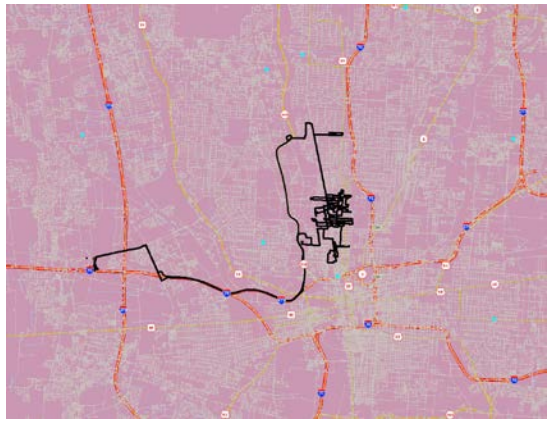
Effect of SUV cut-in

SUV leading 3-truck platoon

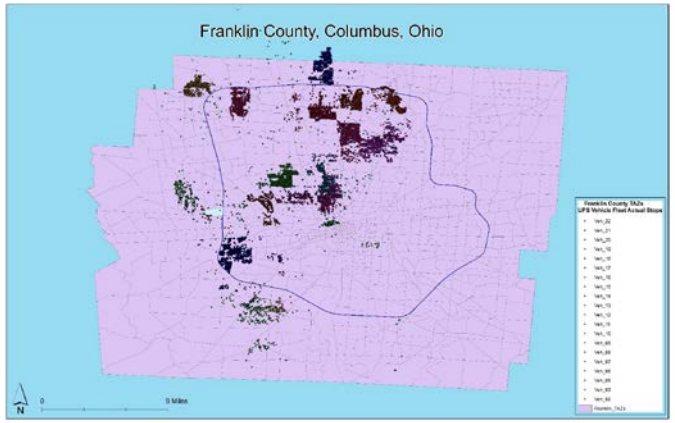


ACCOMPLISHMENT: Freight Tour-based Modeling

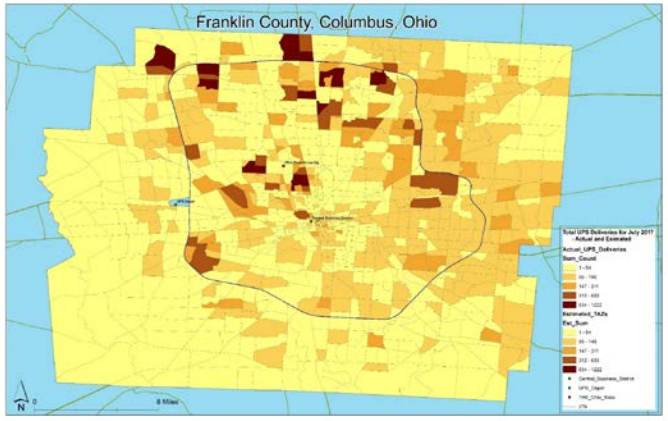
Real-world freight delivery data used to create Freight Delivery Demand Model for Columbus, OH



UPS-provided GPS Tour Route Data



Franklin County, OH UPS delivery Data



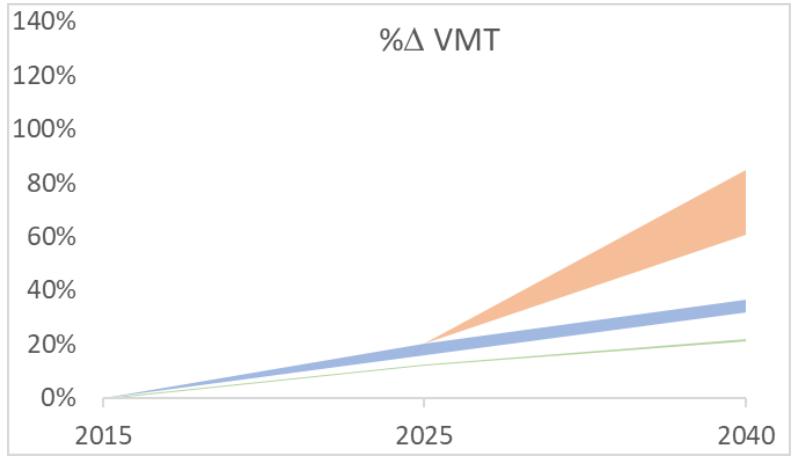
Freight Delivery Demand Estimation Model

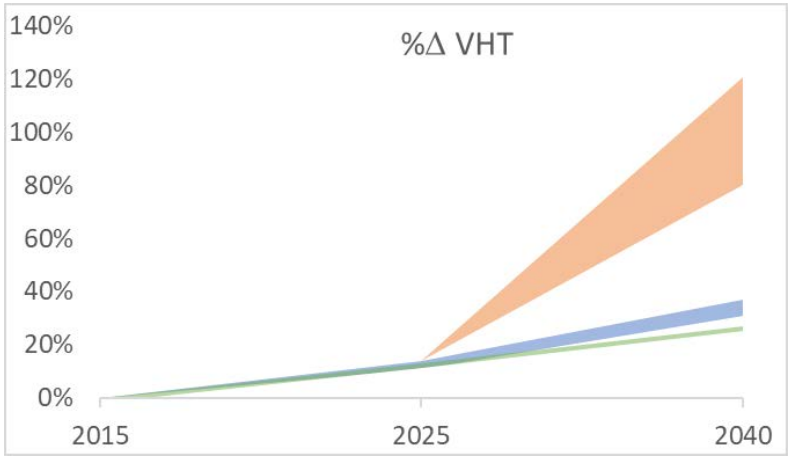
Model applied to specific case-studies to determine energy consumption of different delivery modes

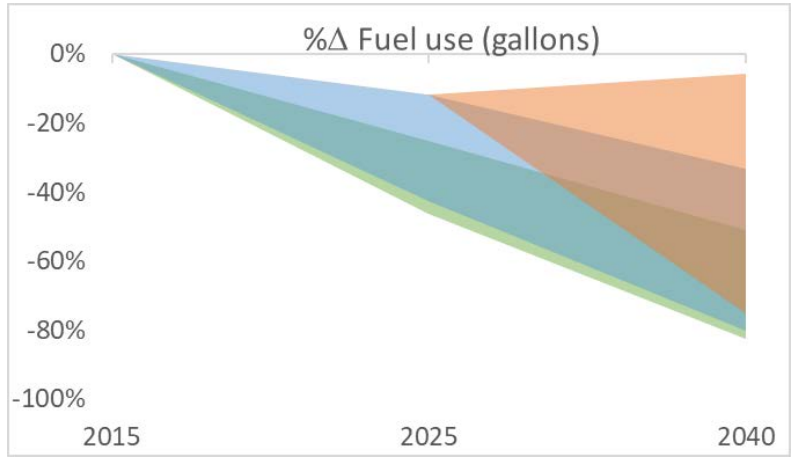
Scenario	Mode	Energy Usage kwh/mile	Total Energy Usage kwh
Baseline – Class 6 UPS Truck makes Deliveries from Depot	Class 6 Truck	4.29	128.96
Class 6 EV Truck makes deliveries from Depot	EV Class 6 Truck	1	30.06
Class 6 UPS Truck makes deliveries to UPS stores; EV delivery van makes final deliveries	EV Delivery Van (eNV200)	.56	78.21
Class 6 UPS Truck makes deliveries to lockers	Class 6 Truck	4.29	66.67
Class 6 EV Truck makes deliveries to lockers	EV Class 6 Truck	1	15.54
Class 6 UPS Truck makes deliveries to locker location; drones make final deliveries	Drone	.1	112.03
City Unit UPS Truck makes deliveries to UPS stores; Uber-style drivers make final deliveries using passenger vehicles	EV Passenger Car (Nissan Leaf)	.34	71.28

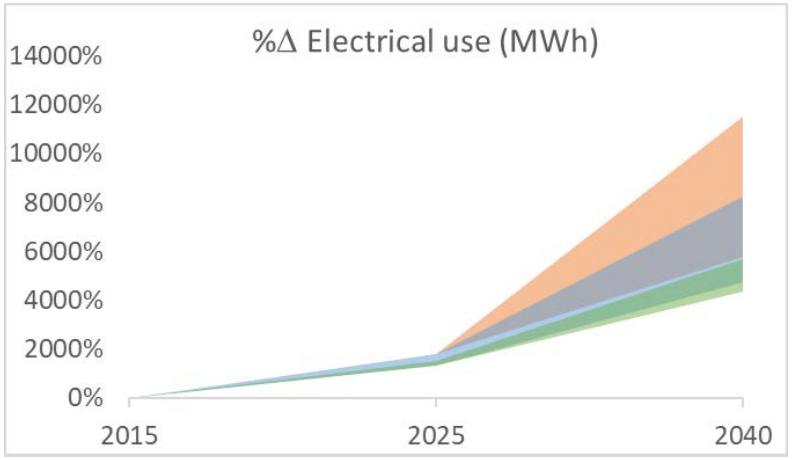
ACCOMPLISHMENT: Impact of CAV Technologies

Range in Performance Metrics over All Scenarios by Year









Base CAV-4 CAV-5

POLARIS

Regional study of Bloomington, IL

Base Case
- Modest increase in VMT/VHT
- Fuel use reduction due to improved powertrain technologies
- Electricity use increase due to powertrain electrification

L4 Automation Case
- Small impact on VMT/VHT due to VOTT reduction
- Additional impact on fuel/electricity use due to sensor accessory load

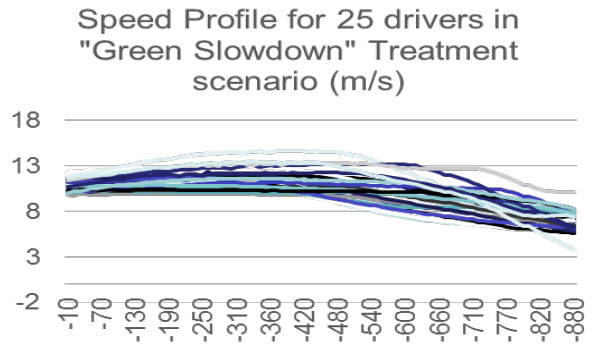
L5 Automation Case
- Additional VMT/VHT due to ZOVs (dead-heading, repositioning) and VOTT
- Significant impact on overall energy consumption

Best case for each scenario is high-tech powertrain case, 600W CAV accessory load, low CAV penetration, charge for ZOVs.

Worst case for each scenario is low-tech powertrain case, 2500W CAV accessory load, high CAV penetration, no charge for ZOVs.

ACCOMPLISHMENT: Traveler Behavior & Mobility

eems001
eems023
eems043



Experimental & survey data on driver response to signal phase and timing information

WholeTraveler
TRANSPORTATION BEHAVIOR STUDY

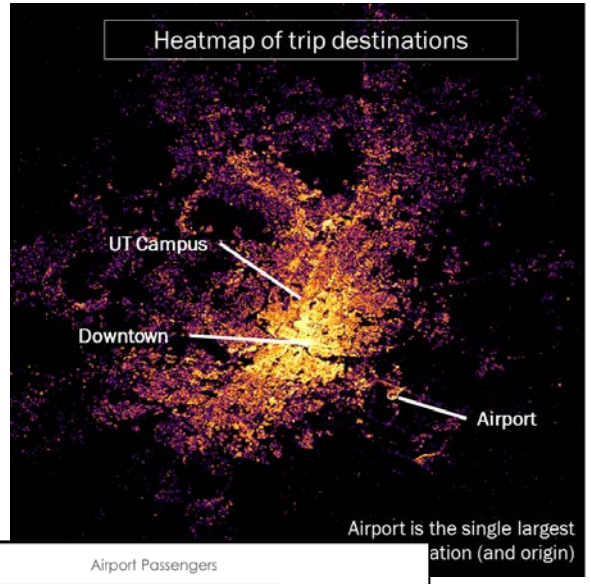
76% Phase 1 Survey Completion Rate
71% Phase 2 Opt-in (GPS collection)
37% Phase 2 Completion Rate

Future Mode Shift

Adopter Traits

Dynamic Lifecycle Stages

WholeTraveler survey deployed and successfully generating data, research & analysis underway

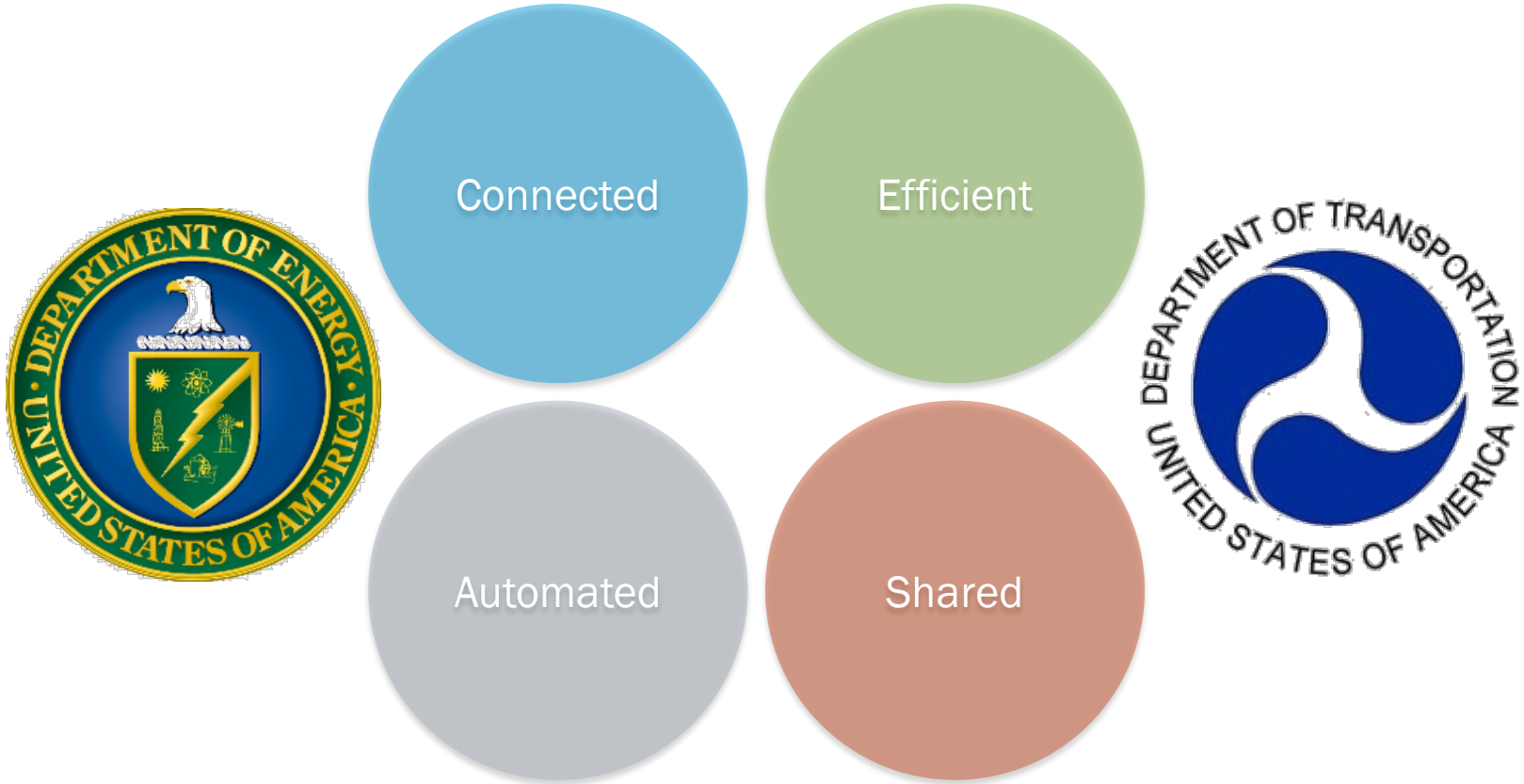


New insights into TNC impacts on mobility behavior (car ownership, airport traffic, parking revenue)

CRITICAL NEED FOR

INTERAGENCY & INDUSTRY COORDINATION

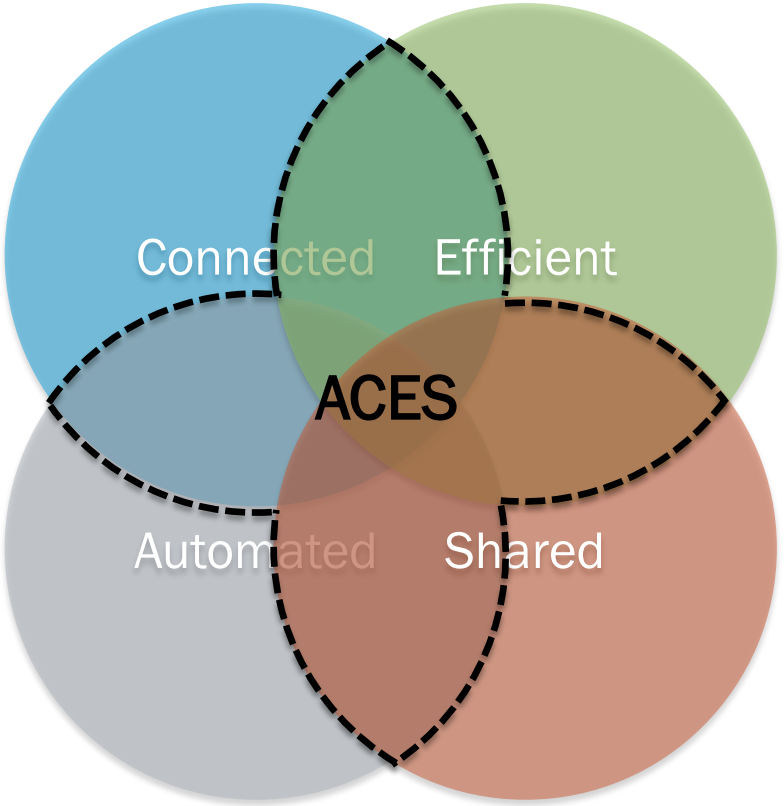
To jointly advance the state-of-the-practice in safety, mobility, and energy efficiency in transportation



CRITICAL NEED FOR

INTERAGENCY & INDUSTRY COORDINATION

To jointly advance the state-of-the-practice in safety, mobility, and energy efficiency in transportation



CRITICAL NEED FOR

INTERAGENCY & INDUSTRY COORDINATION

To jointly advance the state-of-the-practice in safety, mobility, and energy efficiency in transportation

USDRIVE

21st CENTURY TRUCK PARTNERSHIP

CONCLUSION

- A ***major disruption*** is occurring in transportation
- ***Connected & Autonomous Vehicles*** (CAVs) are coming
- ***Mobility as a Service*** (MaaS) is here
- CAVs & MaaS will have ***dramatic implications for energy and mobility***
- VTO's EEMS Program is conducting early-stage R&D to ***improve Mobility Energy Productivity***
- Come to the ***EEMS sessions (Tues/Wed, Salon FGH)*** to learn more!

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

VEHICLE TECHNOLOGIES OFFICE

ENERGY EFFICIENT MOBILITY SYSTEMS PROGRAM

VEHICLES.ENERGY.GOV

Thank You!

David Anderson
David.Anderson@ee.doe.gov

Prasad Gupte
Prasad.Gupte@ee.doe.gov

...And an additional EEMS Technology Manager starting June 25!